EAST Search History

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	14	nanocrystal with SiGe	US-PGPUB; USPAT	OR	ON	2006/11/06 10:32
L2	18	nanocrystal same SiGe	US-PGPUB; USPAT	OR	ON	2006/11/06 10:33
L3	4	2 not 1	US-PGPUB; USPAT	OR	ON	2006/11/06 10:32
L4	2	nanocrystal same SiGe	USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2006/11/06 10:33
L5	37	strained with SiGe with dopant	US-PGPUB; USPAT	OR	ON	2006/11/06 10:38
L6	135	strained with SiGe with (doped or impurity)	US-PGPUB; USPAT	OR	ON	2006/11/06 10:38
L7	111	6 not 5	US-PGPUB; USPAT	OR	ON	2006/11/06 10:38
L8	58	7 and @ad<"20031231"	US-PGPUB; USPAT	OR	ON	2006/11/06 11:31
L9	5473	(substrate with Ge) and @ad<"20031231"	US-PGPUB; USPAT	OR	ON	2006/11/06 10:55
L10	10	(substrate with Ge) and hetrojunction and @ad<"20031231"	US-PGPUB; USPAT	OR	ON	2006/11/06 10:57
L11	197	(substrate with Ge) and (optical with modulator) and @ad<"20031231"	US-PGPUB; USPAT	OR	ON	2006/11/06 10:57
L12	1013	(doped with SiGe) and @ad<"20031231"	US-PGPUB; USPAT	OR	ON	2006/11/06 11:35
L13	306	12 and optical	US-PGPUB; USPAT	OR	ON	2006/11/06 11:32
L14	24	13 and modulator	US-PGPUB; USPAT	OR	ON	2006/11/06 11:32
L15	60	(doped with strained with SiGe) and @ad<"20031231"	US-PGPUB; USPAT	OR	ON	2006/11/06 11:36

EAST Search History

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	1	("6954473").PN.	US-PGPUB; USPAT	OR	OFF	2006/11/06 13:20
L2	664	(optical adj modulator) and (si with substrate)	US-PGPUB; USPAT	OR	ON	2006/11/06 13:29
L3	542	2 and @ad<"20031231"	US-PGPUB; USPAT	OR	ON	2006/11/06 13:29
L4	227	3 and quantum	US-PGPUB; USPAT	OR	ON	2006/11/06 13:21
L5	25	4 and SiGe	US-PGPUB; USPAT	OR	ON	2006/11/06 13:21
L6	38	(optical adj modulator) and (siGe with substrate)	US-PGPUB; USPAT	OR	ON	2006/11/06 13:29
L7	204	(optical adj modulator) and ((Ge or germanium) with substrate)	US-PGPUB; USPAT	OR	ON	2006/11/06 13:29
L8	182	7 and @ad<"20031231"	US-PGPUB; USPAT	OR	ON	2006/11/06 13:29

US-PAT-NO: 6954473

DOCUMENT-IDENTIFIER: US 6954473 B2

TITLE: Optoelectronic device employing at least one semiconductor heterojunction thyristor for producing variable electrical/optical delay

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Brief Summary Text - BSTX (3):
This invention relates broadly to the field of optoelectronics devices, and, more particularly to mechanisms that provide temporal delay to an electrical pulse and/or optical pulse and systems employing such mechanisms. In addition, the invention relates broadly to the field of semiconductor heterojunction devices, and more particularly, to transistors, **optical** emitters, **optical** detectors, **optical modulators, optical** amplifiers and other optoelectronic devices utilizing semiconductor heterojunction devices.

Brief Summary Text - BSTX (7):
Temporal delay of an optical pulse can also be provided in the optical domain utilizing an optical delay line wherein path length of the optical delay line dictates the temporal delay imparted on the input optical pulse. Variable temporal delay is typically implemented by varying optical path length of the optical signal passing through the optical delay line. Path length variation can be realized with a multitude of optical **fibers** and a switch (such as a micromechanical mirror (MEM) switch) that switches the optical signal to one of the **fibers** to set the optical delay. U.S. patent application Publication US2002/0067877 describes an exemplary optical delay line utilizing this approach. Alternatively, path length variation can be realized by supplying the optical signals to a resonant cavity. Switchable mirrors enable the signal to resonate within the cavity (to increase the optical delay time) and escape the cavity for output. U.S. Pat. No. 6,028,693 describes an exemplary optical delay line utilizing this approach. It has also been proposed to use a photonic band gap structure (a plurality of layers which exhibit a series of photonic bandgaps) to provide variable optical delay. U.S. Pat. Nos. 6,396,617 and 5,751,466 describe an exemplary optical delay line utilizing this approach. In U.S. Pat. No. 5,751,466, the amount of delay is varied by applying a predetermined voltage or set of voltages (or by varying the frequency of the applied signal) to the layers of the photonic band gap

structure to vary the index of refraction thereof.

Brief Summary Text - BSTX (9):

Each of these prior art approaches is costly to design and manufacture because it is complex and difficult to integrate with other optoelectronic devices (such as **optical** emitters, **optical** detectors, **optical modulators, optical** amplifiers), electronic devices (such as FET transistors and bipolar transistors), and **optical** devices such as passive **optical** waveguides.

Brief Summary Text - BSTX (10):

Thus, there is a great need in the art for an improved **optical**/electrical pulse delay mechanism that provides accurate and controllable temporal delay and that has lower cost and ease of integration with a broad range of devices such as **optical** emitters, **optical** detectors, **optical modulators, optical** amplifiers, transistors, and passive waveguides.

Brief Summary Text - BSTX (12):

It is therefore an object of the invention to provide a mechanism that provides accurate and controllable **optical**/electrical pulse delay and that has lower cost and ease of integration with a broad range of devices such as **optical** emitters, **optical** detectors, **optical modulators, optical** amplifiers, transistors, and **optical** waveguides.

Brief Summary Text - BSTX (13):

It is another object of the invention to provide an **optical**/electrical pulse delay mechanism that is formed from a multilayer growth structure that can also be used to build a broad range of devices such as **optical** emitters, **optical** detectors, **optical modulators, optical** amplifiers, transistors, and **optical** waveguide devices.

Brief Summary Text - BSTX (14):

It is a further object of the invention to provide an **optical**/electrical pulse delay mechanism utilizing a thyristor device formed from a multilayer growth structure that can also be used to build a broad range of devices such as **optical** emitters, **optical** detectors, **optical modulators, optical** amplifiers, transistors, and **optical** waveguide devices.

Brief Summary Text - BSTX (18):

According to the present invention, an optoelectronic integrated circuit comprises a resonant cavity formed on a substrate. A heterojunction thyristor device is formed from a multi-layer structure in the resonant cavity. The heterojunction thyristor device detects an input optical pulse (or input

electrical pulse) and produces an output optical pulse via laser emission in response to the detected input optical pulse (input electrical pulse) for output outside the resonant cavity. There is a time delay between the input optical pulse (or input electrical pulse) and the output optical pulse, the magnitude of which depends upon the operational characteristics of the device, including bias current supplied to the active **quantum well** channels therein, amplitude of the input optical pulse (or input electrical pulse) and other device characteristics.

Brief Summary Text - BSTX (19):
The heterojunction thyristor device also produces an output electrical pulse synchronous to the output optical pulse. Thus, there is a time delay between the input optical pulse (or input electrical pulse) and the output electrical pulse. The magnitude of this delay depends upon the same operational characteristics of the device, including bias current supplied to the active **quantum well** channels therein, amplitude of the input optical pulse (or input electrical pulse) and other device characteristics.

Brief Summary Text - BSTX (20):
According to one embodiment of the present invention, the heterojunction thyristor device includes a channel region operably coupled to a current source that draws constant bias current from active **quantum well** channel(s) of the device. An input optical pulse is injected into the resonant cavity which is resonantly absorbed in the active **quantum well** channel(s), which produces a charge in the active **quantum well** channel(s) sufficient to switch the device into a conducting/ON state. In the ON state, the device operates in lasing mode to produce light that forms the output optical pulse. After the input optical pulse terminates, the device switches into the OFF state because the bias current draws charge from the active **quantum well** channel(s). In the OFF state, laser emission ceases and the output optical pulse terminates. The heterojunction thyristor device also produces an output electrical pulse (at its cathode terminal) synchronous to the output optical pulse. The time delay between the input optical pulse and the output optical pulse (output electrical pulse) is controllably varied by modulating the amplitude of the input optical pulse.

Brief Summary Text - BSTX (21):
Alternatively, instead of injecting an input optical pulse into the resonant cavity, an input electrical pulse can be injected into active **quantum well** channel(s) of the device. This input electrical pulse operates similar to the input optical pulse to produce charge in the active **quantum well** channel(s) sufficient to switch the device into the ON state. In the ON state, the device

operates in lasing mode to produce light that forms the output optical pulse. After the input electrical pulse terminates, the device switches into the OFF state because the bias current draws charge from the active **quantum well** channel(s). In the OFF state, laser emission ceases and the output optical pulse terminates. In this configuration, the heterojunction thyristor device produces an output electrical pulse (at its cathode terminal) synchronous to the output optical pulse. The time delay between the input electrical pulse and the output optical pulse (output electrical pulse) is controllably varied by modulating the amplitude of the input electrical pulse.

Brief Summary Text - BSTX (23):
Alternatively, instead of injecting an input optical pulse into the resonant cavity, an input electrical pulse can be injected into active **quantum well** channel(s) of the device. This input electrical pulse operates similar to the input optical pulse to produce an output optical pulse (and synchronous output electrical pulse) as summarized above. In this second embodiment, time delay between the input electrical pulse and the output optical pulse (and synchronous output electrical pulse) is controllably varied by regulating the amount of bias current drawn by the current source.

Brief Summary Text - BSTX (24):
According to other embodiments of the present invention, monolithic optoelectronic integrated circuits that include a heterojunction thyristor device formed from a multi-layer structure in the resonant cavity are integrated with other optoelectronic devices (such as **optical** emitters, **optical** detectors, **optical modulators, optical** amplifiers), electronic devices (such as transistors) in addition to **optical** devices (such as waveguide devices).

Drawing Description Text - DRTX (5):
FIG. 1C is a graph showing the current-voltage characteristics of the heterojunction thyristor devices of the present invention over varying injector currents (I.sub.g), and the bias line that depicts operation of the heterojunction thyristor device as a detector/**modulator** that detects an input **optical** pulse (or input electrical pulse) and produces an output **optical** pulse via laser emission in response to the detected input pulse. An output electrical pulse that is synchronous to the output optical pulse is also produced after the time delay.

Drawing Description Text - DRTX (13):
FIG. 3A is a schematic illustrating the use of an analog **optical modulator** and heterojunction thyristor that operate to detect an input **optical** pulse, and produce an output **optical** pulse (and output electrical pulse) with variable

time delay between the input **optical** pulse and the output **optical** pulse (and output electrical pulse).

Drawing Description Text - DRTX (25):
FIG. 9 is pictorial illustration of a monolithic optoelectronic integrated circuit in accordance with the present invention, including passive in-plane waveguides, an analog **optical modulator,** a heterojunction thyristor device, and a load FET resistor integrated thereon.

Drawing Description Text - DRTX (26):
FIG. 10 is a cross-sectional schematic view showing the generalized construction of an exemplary embodiment of an analog **optical modulator** that is part of the monolithic optoelectronic integrated circuit shown in FIG. 6.

Detailed Description Text - DETX (2):
Modulation-doped **quantum well** heterojunction transistors--including **well** known Pseudomorphic Pulsed Doped High Electron Mobility Transistors (Pulsed Doped PHEMT), which are sometimes referred to as Pulsed Doped Modulation Doped Field Effect Transistors (Pulsed Doped MODFET) or Pulsed Doped Two Dimensional Gas Field Effect Transistors (Pulsed Doped TEGFET)--have become **well** recognized for their superior low noise and high frequency performance and are now in demand in many high frequency applications (e.g., front end amplifier in wireless communications systems and in Monolithic Microwave and Millimeterwave IC (MMIC) designs).

Detailed Description Text - DETX (4):
U.S. Pat. No. 4,827,320 to Morkoc et al. discloses a pseudomorphic HEMT (PHEMT) structure that employs a layer of strained InGaAs (undoped) between a GaAs substrate and a layer of undoped AlGaAs to form a **quantum well** defined by the strained InGaAs layer. A layer of n+ doped AlGaAs is formed on the undoped AlGaAs layer. A layer of n+ GaAs is formed on the layer of n+ doped AlGaAs. The layer of n+ GaAs facilitates an ohmic contact to source/drain electrodes. A gate electrode of aluminum is recessed below the layer of n+ GaAs and a portion of the n+ AlGaAs layer by wet chemical etch and evaporation of aluminum.

Detailed Description Text - DETX (12):
The present invention builds upon novel device structures utilizing modulation-doped **quantum well** heterojunctions that do not suffer from the problems associated with the prior art PHEMT devices. Such novel device structures are described in detail in U.S. Pat. No. 6,031,243; U.S. patent application Ser. No. 09/556,285 filed on Apr. 24, 2000; U.S. patent

application Ser. No. 09/798,316 filed on Mar. 2, 2001; U.S. patent application Ser. No. 08/949,504 filed on Oct. 14, 1997, U.S. patent application Ser. No. 10/200,967 filed on Jul. 23, 2002; U.S. application Ser. No. 09/710,217 filed on Nov. 10, 2000; U.S. patent application Ser. No. 60/376,238 filed on Apr. 26, 2002; each of these references herein incorporated by reference in its entirety.

Detailed Description Text - DETX (13):

In accordance with the present invention, a heterojunction thyristor device is configured to operate as an optical detector that detects an input optical pulse and as a vertical cavity laser that produces an output optical pulse in response to the detected input optical pulse. A variable time delay between the input optical pulse and output optical pulse (and the output electrical pulse) is controlled by modulating the optical power of the input beam or by varying a bias current supplied to the injector control terminal (which is analogous to the gate terminal of conventional thyristor devices). The general structure of the heterojunction thyristor device is illustrated in the cross-section of FIG. 1A. In addition, the general structure of FIG. 1A can be configured to operate as an **optical modulator** that modulates the **optical** signal passing through the device, as a field effect transistor, and as a passive waveguide as described herein in detail such that these devices can be integrated to form a monolithic optoelectronic integrated circuit as described herein.

Detailed Description Text - DETX (14):

Turning now to FIG. 1A, the heterojunction thyristor device 1 of the present invention includes bottom dielectric distributed bragg reflector (DBR) mirror 12 formed on substrate 10. The bottom DBR mirror 12 typically is formed by depositing pairs of semiconductor or dielectric materials with different refractive indices. When two materials with different refractive indices are placed together to form a junction, light will be reflected at the junction. The amount of light reflected at one such boundary is small. However, if multiple junctions/layer pairs are stacked periodically with each layer having a quarter-wave (.lambda./4n) optical thickness, the reflections from each of the boundaries will be added in phase to produce a large amount of reflected light (e.g., a large reflection coefficient) at the particular center wavelength .lambda..sub.D. Deposited upon the bottom DBR mirror 12 is the active device structure which consists of two HFET devices. The first of these is a p-channel HFET 11 (comprising layers 14,16,18,20 and 22) which has one or more p-type modulation doped **quantum wells** and is positioned with the gate terminal on the lower side (i.e. on the mirror as just described) and the collector terminal on the upper side. The second of these is an n-channel HFET

13 (comprising layers 22,24,26,28,30) which has one or more n-type modulation doped **quantum wells** and is positioned with the gate terminal on the top side and the collector terminal on the lower side which is the collector of the p-channel device. Therefore a non-inverted N-channel device is stacked upon an inverted p-channel device to form the active device structure.

Detailed Description Text - DETX (15):
The active device layer structure begins with n-type ohmic contact layer(s) 14 which enables the formation of ohmic contacts thereto. As shown, ohmic contact layer 14 is operably coupled to cathode terminal 40 of the heterojunction thyristor device (which corresponds to the gate electrode of the p-channel HFET device 11). Deposited on layer 14 is one or more n-type layers 16 and an undoped spacer layer 18 which serve electrically as part of the P-channel HFET gate and optically as a part of the lower waveguide cladding of the device. Deposited on layer 18 is a p-type modulation doped heterojunction structure 20 that defines one or more **quantum wells** (which may be formed from strained or unstrained heterojunction materials). Deposited on p-type modulation doped heterojunction structure 20 is an undoped spacer layer 22, which forms the collector of the P-channel HFET device. All of the layers grown thus far form the P-channel HFET device with the gate ohmic contact on the bottom.

Detailed Description Text - DETX (16):
Undoped spacer layer 22 also forms the collector region of the N-channel HFET device. Deposited on layer 22 is a n-type modulation doped heterojunction structure 24 that defines one or more **quantum wells** (which may be formed from strained or unstrained heterojunction materials). Deposited on the n-type modulation doped heterojunction structure 24 is an undoped spacer layer 26 and one or more p-type layers 28 which serve electrically as part of the n-channel HFET gate and optically as part of the upper waveguide cladding of the device. Preferably, the p-type layers 28 include two sheets of planar doping of highly doped p-material separated by a lightly doped layer of p-material. These p-type layers are separated from the N-type modulation doped **quantum well** (QW) heterostructure 24 by undoped spacer material 26. In this configuration, the top charge sheet achieves low gate contact resistance and the bottom charge sheet defines the capacitance of the n-channel HFET with respect to the N-type modulation doped QW heterostructure 24. Deposited on p-type layer(s) 28 is a p-type ohmic contact layer(s) 30 which enables the formation of ohmic contacts thereto. As shown, ohmic contact layer(s) 30 is operably coupled to the anode terminal 36 of the heterojunction thyristor device (which corresponds to the gate electrode of the n-channel HFET device).

US-PAT-NO: 6424450

DOCUMENT-IDENTIFIER: US 6424450 B1

TITLE: **Optical modulator** having low insertion loss and wide bandwidth

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Abstract Text - ABTX (1):

A modulator that provides low insertion loss and wide bandwidth. The modulator has a single layer, quarter wave membrane that is suspended over a substrate. The membrane has a refractive index, n.sub.m, in a range of about 1.1n.sub.s.sup.0.5.ltoreq.n.sub.m.ltoreq.1.4n.sub.s.sup.0.5. When actuated, the membrane moves toward the substrate, altering the reflectivity of the modulator. In some embodiments, the **substrate is germanium,** which has a protective layer disposed thereon to protect it from etchant during MEMS fabrication procedures.

Application Filing Date - AD (1):

20001129

TITLE - TI (1):

Optical modulator having low insertion loss and wide bandwidth

Brief Summary Text - BSTX (2):

The present invention pertains to **optical modulators**. More particularly, the present invention relates to micro electromechanical systems (MEMS)-based **optical modulators** that rely on optical interference as a principle of operation.

Brief Summary Text - BSTX (4):

Some **optical modulators** are capable of varying the intensity of an optical signal. This intensity variation can be achieved using optical interference principles. Modulators relying on this operating principle typically incorporate an optical cavity that is defined by two spaced surfaces having appropriate indices of refraction. Varying the size of the gap between the two surfaces alters the reflectivity of the optical cavity.

Brief Summary Text - BSTX (5):